Landscape and Urban Planning 180 (2018) 262–272

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

The challenge of urban poverty for the use of green infrastructure on floodplains and wetlands to reduce flood impacts in intertropical Africa

Ian Douglas

School of Environment, Education and Development, University of Manchester, Manchester, M13 9PL, UK

HIGHLIGHTS

- Green infrastructure, including urban agriculture, helps flood management.
- African informal settlements encroach on floodplains and wetlands.
- Poor people rely on living and farming in urban floodplains and wetlands.
- Local politics complicate planning and management of integrated urban drainage.
- African cities need holistic multi-sectoral thinking and action to reduce flood risks.

ARTICLE INFO

Article history:
Received 28 September 2015
Received in revised form 3 September 2016
Accepted 10 September 2016
Available online 19 November 2016

Keywords:
Flooding
Green infrastructure
Poverty
Africa
Political influence
Informal settlements

ABSTRACT

The rapidly expanding urban population in intertropical African cities that lives in poverty in informal settlements poses major problems for urban health, safety and risk reduction. Such settlements often encroach on floodplains and wetlands, restricting the space available to convey and store flood waters Climate change and the expansion impermeable urban surfaces are contributing to increased magnitude and frequency of flooding. The use of green infrastructure in Africa to alleviate climate change impacts, including for sustainable urban drainage, is widely advocated. Many consider that urban agriculture can be part of such green infrastructure. However, although municipal plans often envisage removal of settlements from floodplains and do not encourage urban agriculture, efforts to bulldoze dwellings and move people from the settlements close to city centres are strongly resisted and can become politically contested. Improvements in urban drainage require participatory, multi-sectoral planning and implementation. In many African cities three different levels of action occur, frequently without considering interests at any other level: municipal drainage and floodplain clearance plans; international NGO and consultant led schemes; and community-based small scale actions for immediate relief and protection. Political allegiances cut across the three levels, showing that without holistic views across all scales of the political, social, economic and environmental aspects of these intertropical African cities, widespread use of floodplain and wetland green infrastructure for flood hazard reduction will be difficult to achieve.

1. Introduction

The vulnerability of urban populations to natural hazards and climate change is a major theme in many reports on Africa's cities (Lwasa et al., 2014; Satterthwaite, Huq, Pelling, Reid, & Romero Lankao, 2007; Simon, 2013; UNHabitat, 2014), with flooding ranking highly among the climate change concerns (Jean-Baptiste, Kabisch, & Kuhlicke, 2013; Ponte, 2014). Flooding arises from extreme rainfalls, but its impact is changed by modifications to land cover and to stream and river channels. In urban areas, such modifications are at their most extreme and most pervasive in their effects on human lives (Douglas, 1983). Urban river floodplains are frequently partly built upon, constrained by retaining walls, bridges and embankments and used for many activities, from sportsgrounds to urban agriculture, informal settlements and rubbish dumps. In this perspective essay the possibility that the many forms and scales of encroachment and occupation of urban floodplains in intertropical Africa create particularly intractable issues for flood mitigation is explored. A key issue is whether the existing

E-mail addresses: ian.douglas@manchester.ac.uk, iandouglas66@yahoo.com

http://dx.doi.org/10.1016/j.landurbplan.2016.09.025
0169-2046/

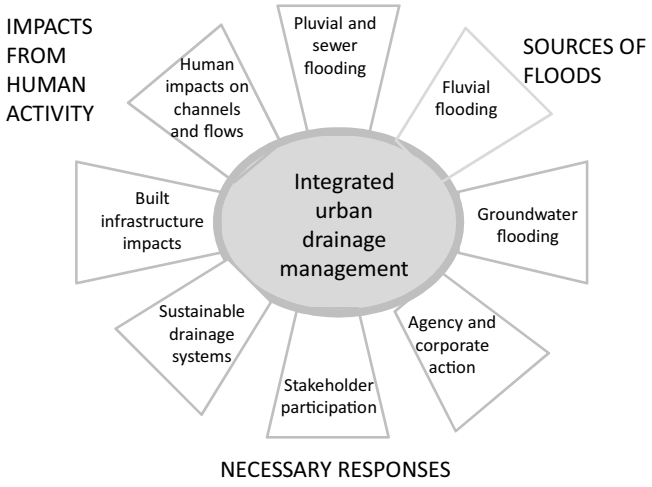

Fig. 1. Components of integrated urban drainage management in tropical African cities.

Fig. 2. Low earth barriers built across paths to divert floodwaters in an informal settlement in Lusaka, Zambia.

competition for use of the floodplain, such as between informal urban agriculture and landfilling for construction, can give way to a broader strategy of multifunctional urban green infrastructure. In particular, there is much to suggest that many forms of adaptation to reduce the impacts of flooding, especially increasing building resilience, widening drainage channels, and creating detention ponds, are extremely difficult to achieve in low-income settlements (Satterthwaite, Huq, Pelling, Reid, & Romero Lankao, 2009).

Concern about such encroachment upon floodplains is a global phenomenon. Much legislation and many guidelines endeavour to keep floodplains free of development to enable stormflows to pass through cities without causing serious damage and financial hardship (Mance, Raven, & Bramley, 2002; Penning-Rowsell & Tunstall, 1996). Heightened worries about changes of the magnitude and frequency of floods have increased the need for integrated land and water management to reduce flood risk (OST, 2004). Integrated urban drainage management (Fig. 1) is a subset of overall land and water management with urban floodplain management as a key component. Floodplain management sets out to: limit the effects of flooding on human well-being, health and safety; limit damage to property; sustain the natural functions of floodplains in terms of conveyance and storage of water and other ecosystem services; and encourage the multifunctional use of floodplains to benefit the community (Standing Committee on Agriculture and Resource Management Australia, 2000). Such multifunctional use can be compatible with urban green infrastructure which includes areas for nature conservation, urban agriculture, sporting activities, recreational uses and woodland (Benedict & McMahon, 2002). Thus urban green infrastructure ideally should be explicitly considered during planning, particularly in floodplains, so that the limited space can be used more effectively (Ahern, 2007; Hansen & Pauleit, 2014). In Africa, strong arguments are made that green infrastructure including all forms of urban agriculture can contribute to flood alleviation (Connors, Griffith, Nolasco, Wahab, & Mugagga, 2016; Prain & Lee-Smith, 2010; Lwasa et al., 2014). Demand for urban and peri-urban land for food growing may increase as climate change affects crop yields in rural areas and as migration leads to growing urban populations, increasing the intensity of agriculture on floodplains (Satterthwaite, McGranahan, & Tacoli, 2010).

Green infrastructure contributes to soft engineering approaches to flood hazard reduction, in terms of water conveyance as retention over floodplains and to surface runoff attenuation on slopes draining towards rivers. Since the 1970s, grassed waterways and detention ponds have been adopted to control urban runoff and erosion in Australia and North America (Hannam & Hicks 1980; Hannam, 1979; Robinson & Speiker, 1978). Subsequently such measures have been included in the concept of sustainable urban drainage systems (SuDS) whose applicability to the African situation is now being examined (Mguni, Herslund, & Jensen, 2015). SuDS are a key part of the strategy of "Making Space for Water" adopted in England in 2004 to develop new approaches to flood control and coastal management (Defra, 2005). SuDS interventions require integrated action between stakeholders, residents, local governments, utility companies, and any such river basin management organizations that exist. Community involvement is particularly important (Mitchell, 2006; Rauch, Seggelke, Brown, & Krebs, 2005). Many of the factors affecting local nuisance flooding from heavy, short duration, tropical thunderstorms, such as blocked culverts, siltation of local drains, or diversion of floodwater by temporary barriers set up to protect individual properties, are related to activities and behavior in the community (Fig. 2). Such phenomena have to be avoided if a larger scale SuDS strategy is to be effective.

Few long-term strategies to retrofit SuDS within existing tropical urban African catchments in order to increase space for water have been documented (Iwugo, Andoh, & Feest, 2002). However, a pilot scheme undertaken in Djenne, Mali (Alderlieste & Langeveld, 2005), installed infiltration devices to reduce the silting up of drains in many parts of the city. Greenways were developed by an urban and peri-urban agriculture and forestry (UPAF) project to improve adaptive capacity in Bobo-Dioulasso in Burkina Faso by: restoring, protecting and managing biodiversity; reducing flood risk by modifying water flows; providing for forest production and market-gardening; and developing recreational spaces and environmental awareness (UNHabitat, 2014). Although changes in maintenance and management practices have been made to address local urban drainage problems in several African cities, including Rufisque in Senegal (Gaye & Diallo, 1997), Nairobi in Kenya (ActionAid, 2006) and Dar es Salaam in Tanzania (Majani, 1996), they did not involve using SuDS techniques.

2. The context of urban floodplain management in inter-tropical Africa

High birth rates and migration to towns and cities from rural areas are driving the present rapid urbanization in Africa. Between 2010 and 2050, Africa's urban population is forecast to increase from 400 million to 1.26 billion (UNHabitat, 2014). Tropical Africa's seven largest megacities will more than double their populations between 2000 and 2025 (Table 1). Much of that growth will take

Table 1
Past and projected population numbers for Africa's seven largest megacities (thousands).

Urban agglomeration	1985	2000	2015	2025 (projected)
Lagos	3500	7281	13000	18957
Kinshasa	2722	5414	11600	14535
Khartoum	1611	3505	5500	7090
Dar-es-Salaam	1046	2116	5100	7276
Abidjan	1716	3028	4900	6971
Nairobi	1090	2214	3900	6143
Kano	1861	2602	3600	5721

(Sources: 1985, 2000 and 2025 projection: Mo Ibrahim Foundation, 2016; UNHabitat, 2014).

Table 2
Countries with the highest and lowest proportions on urban dwellers living in slums in four regions of intertropical Africa.

Region	Country with highest %	%	Country with lowest %	%
Western Africa	Niger	81.9	Senegal	38.1
Eastern Africa	Ethiopia	79.1	Kenya	54.8
Central Africa	Central African Republic	95.0	Cameroon	46.6
Southern Africa	Mozambique	80.0	Zimbabwe	19.0

(Source: UNHabitat, 2014).

place in informal settlements, where population densities can reach 80,000 per km^2 (Wakhungu, Huggins, Nyukuri, & Lumumba, 2010). In some tropical African countries, more than 80% of the urban population lives in informal settlements (Table 2), many of which are on steep slopes or the edges of wetlands or the margins of floodplains. Often their residents grow food crops on the floodplain. The people live from day to day. Loss of casual work, damage to their crops or sudden illness can mean no money to buy essential food. Under such conditions, many people have little built-in resilience due to limited assets and resources. Inadequate access to safe water, sanitation, drainage and solid waste collection, coupled to limited educational opportunities traps people within a cycle of poverty and to life in informal settlements (Heath, Parker, & Weatherhead, 2012). However, many long-term residents develop complex social and economic networks that enable them to undertake community projects and to campaign for local improvements. Thus informal settlements are highly differentiated and demonstrate great social and economic heterogeneity (Ricci, 2016).

Increasing financial instability has resulted in informal settlements having many dwellings that are rented out, rather than having been constructed by their occupiers (Wakhungu et al., 2010). Often the inhabitants of these settlements are under threat of eviction and lack security of tenure (Klopp, 2008; Otiso, 2002). This may create a lack of commitment to a specific community and a lack of concern for the local environment and the well-being of other residents and thus difficulty in getting cohesive community action to work to reduce flood risks through efforts to clear drains, manage local waste adequately, and develop sustainable pathways for runoff (Durand-Lasserve, 2006; Mutisya & Yarime, 2011). Nevertheless, where areas have had long-term resident groups for many years, some strong community organizations exist, such as those affiliated to Shack/Slum Dwellers International (SDI) (Weru, 2004). Such community cohesion can trigger local action on drainage and make the introduction of greenspace schemes and SuDS easier than elsewhere. However, power relations both within informal settlements and between the settlements and the rest of the city can be problematic.

Typically, African cities are economically controlled by small political or economic elites, while the vast majority of dwellers eke out a survival. Spatially, the urban landscape in Africa is the contrast between the spacious gated communities of the wealthy and the closely packed, insubstantial shelters of the poor. Yet these communities are interdependent. Because much of the public and private sector workforce lives in the informal settlements, conditions in deprived areas have an impact on the whole urban population, particularly in terms of public health hazards. Much of the waste from richer homes ends up being sorted for recycling by workers in the informal sector. Floods in informal settlements may be caused partly by runoff from the gated estates and luxury apartment block developments on higher ground. Thus conditions in one part of a city and in one sector of urban society have side effects on other areas and sectors. The interdependence has to be considered carefully when planning green infrastructure and flood mitigation works. Herein reside the tasks of this essay: Can urban greenspace provide adequate ecosystem services for floodwater conveyance and storage, while also supplying provisioning services for the urban poor and space for informal settlements? Is there a conflict between needs at the local community level and the requirements of city-wide integrated urban water management and flood mitigation? What examples are there of ways of successfully introducing flood and drainage management into informal settlements? What difficulties are being encountered in trying to make space for water in intertropical African cities? In seeking answers to these questions, personal experience over 40 years of flood issues in different continents, involvement in three projects in Africa, and discussions with colleagues at workshops and during research projects, were augmented by an extensive review of recent literature and media reports.

3. Findings from the literature review

3.1. Urban greenspace and provisioning services for the urban poor

Urban and peri-urban agriculture has a significant role in food and nutrition security in most low-income nations, but in many cities the urban poor are finding it increasingly difficult to get access to the land to grow crops (Lee-Smith, 2010; Smit, Nasr, & Ratta, 1996). During the 1990s, 17–36% of the population were growing crops and/or keeping livestock in East African towns and cities (Lee-Smith, 2010). These urban farmers were highly varied in experience – for instance, in Dar es Salaam, they included professionals, teachers, government officials, urban planners, students, casual laborers, the unemployed and part-time workers (Sawio, 1994). At that time in Nairobi, Kenya, vegetables were being grown on the banks of the Nairobi River close to the center of the city. Google Earth imagery reveals that such urban agriculture has now moved out of the center. In inner city informal settlements such as Mukuru, dwellings are built right up to the edge of the river, with no space for floodwaters. Residents prepare for floods, strategically abandoning their homes during floods and then return when the floodwaters subside (mobility). People also move to higher ground or areas assigned by the city council, traditional authorities, churches or military depots (Thorn, Thornton, & Helfgot, 2015).

In informal settlements further out of town, for example in Mathare, patches of cultivation exist along the river. Such areas are flooded each wet season. The floodwaters carry industrial effluent and human waste, which include plant nutrients, but can also contaminate crops with heavy metals and many organic compounds (Foeken & Mwangi, 1998). Nevertheless, the farmers use polluted waters and raw sewage as fertilizers, almost half the vegetable consumed in Nairobi being grown along the banks of polluted rivers (UNEP, 2009). Concern about polluted water however, led to a project in Mathare to build a 60 cm high embankment around a vegetable garden to prevent flooding of the crops, with eventu-

Table 3
Impacts of flooding on urban agriculture in intertropical African countries.

Location	Impact	Source
Beneficial		
Nairobi, Kenya	Additional water and nutrients inputs to the soil	Foeken and Mwangi (2000)
Ibadan,Nigeria	Additional water and nutrients inputs to the soil; depostion of soil and silt on floodplain	Onifade, Adio-Moses, Adigun, Oguntunji, and Ogungboye (2014)
Antananarivo, Madagascar	Water with high organic content improves water cress yields	Aubry et al. (2012)
Harmful		
Ilorin, Nigeria	Disruption of electricity supplies; Halting trading; Washing away crops;	Olorunfemi and Raheem (2013)
Monrovia, Liberia	Loss of crops and household income; food shortages	Holder (2014)
Harare, Zimbabwe	Livelihoods disrupted; crops ruined: contamination by polluted water	Mupedziswa (2011), Zvigadza (2008), Mbiba (2000)
Nairobi, Kenya	Risks from contaminated water	Dixon and Wood (2003)
Mombasa, Kenya	Impact of coastal salt water penetration during coastal flooding and water logging affecting crops	Gichere, Sikoyo, and Saidi (2011)
Ibadan, Nigeria	Severe crop losses; Difficulties in getting produce to markets; Loss of fish from fishponds, poultry from poultry sheds,livsestock from river bank farms;	Onifade et al. (2014), Amusat and Amusat (2013)
Antananarivo, Madagascar	Negative consequences on rice yields; longer periods of waterlogging	Aubry et al. (2012)
Lagos, Nigeria	Difficulty of access to farmed plots during floods at wet season rains	Taiwo (2014)

ally a protective levee of locally made gabions (Cimini & Orazi, 2016). Flooding and safe crop production are not really compatible (Table 3). However, many argue that urban agriculture contributes to urban green infrastructure whose ecosystem services include flood hazard reduction (Dubbeling & de Zeeuw, 2011; Lwasa et al., 2014). Inherent to this discussion is the magnitude and frequency of floods. While a frequent flood, occurring perhaps on average once or twice a year, may bring benefits, a bigger, but rarer, flood may cause major disadvantages and losses.

In most cities, pressures on the urban floodplains are increasing. In Addis Ababa, modelling studies suggest that another 31% of existing riverine vegetation may be lost between 2011 and 2025 (Lindley et al., 2015). The problem is not just that of increased runoff from larger paved impermeable surfaces and possible higher intensity storms, but also of declining space for water in the floodplain itself.

3.2. Conflict between needs at the local community level and the requirements of city-wide integrated urban water management and flood mitigation

Most municipal plans for river restoration and flood alleviation in intertropical Africa involve relocation of economic activities and dwellings from the floodplain (Foeken & Maranji, 2000; NEMA, 2009). The proposal to improve drainage in Nairobi clearly sets out many problems associated with informal settlements and other activities on urban floodplains, recognizing that "some sections of these riparian lands have been settled by encroachers and illegal occupants/squatters" (African Development Bank Group, 2010). The project aimed to install sewerage pipes without having to relocate people, but accepted that compensation would have to be paid for crops lost and buildings that had to be removed. Nearly 15,000 people could be affected. Engagement with residents and provision of construction work for young people were seen as ways of helping local people appreciate the benefits of the scheme. Many authorities have difficulty in applying regulatory powers to demolish structures constructed in designated floodways (Owusu-Ansah, 2016).

Even if compensation and alternative living spaces were offered to relocated people, many would tend to return to their informal settlements because the new locations are long distances from employment opportunities (Thorn et al., 2015). Improvements to river corridors may also lead to increased land values, making areas attractive to developers to the disadvantage of the original informal settlement occupants (Mguni et al., 2015). There is a conflict between planning for flood alleviation at the municipal scale and more localized community and household adaptations to flooding and livelihood survival strategies. Thus national and municipal strategies are difficult to apply at the local level (Cissé et al., 2011).

3.3. Successful introduction of flood and drainage management into informal settlements

A prominent attitude in intertropical African urban planning is that informal settlements are illegal and should be removed (Thorn et al., 2015). For administrators therefore, removal of informal dwellings from the floodplain can contribute to the successful introduction of floodplain management. However, many civil society organizations are working to fit flood mitigation into existing informal settlements, for example, some 20 NGOs and CBOs work in clearing drains in Kampala, Uganda (Tukahirwa, Mol, & Oosterveer, 2010). Finance from the Ugandan Government's Community Upgrading Fund has enabled local communities to carry out work to divert floodwaters, improve drainage and store rain water (Dobson, Nyamweru, & Dodman, 2015). In St. Louis, Senegal, the international NGO ENDA – Tiers Monde assisted in setting up a consensus leading to multi-level collaboration involving community organizations in flood mitigation work in many parts of the city (Diagne, 2007; Vedeld, Coly, Ndour, & Hellevik, 2016). Some communities find their own ways of adapting to newly installed SuDS. One of the storm runoff ponds installed in the Mbezi valley of Dar-es-Salaam, which is also fed by a high water table, is being used by local residents for watering crops, washing clothes and recreation (Mguni et al., 2015).

3.4. Difficulties encountered in trying to make space for water in African cities

Resistance to relocation occurs in most attempts to remove buildings for redevelopment. This is particularly so in the case of informal settlements. Rehousing often involves moving away from work locations and to dwellings that are too small or too inflexible for growing families (Cissé & Séye, 2016). Evicted residents often return to the same place (Chitekwe-Biti, Mudimu, Nyama, & Jera, 2012; Gillespie, 2016a). However, attitudes to relocation may differ between tenants and property owners. Tenants may be more willing to move because their stake in the community is brief and insecure. Owners on the hand may have a greater connection and sense of responsibility towards a particular place (Hooper & Ortolano, 2012). Overall, great understanding of how informal settlement communities work and of the relationship and political power distribution both within settlements and between settlements and local authorities is required if SuDS are to be introduced into informal settlement areas successfully (Gillespie, 2016a;

Mguni et al., 2015). At the moment however, generally the goals of local governments and of communities in informal settlements differ, making the clearance of space for floodwaters extremely challenging.

4. Urban floodplains as contested spaces: a simple model and four case studies

The four questions raised at the end of Section 2 lead to a set of potential conflicts: (a) between residents objectives and wider municipal goals concerning urban greenspace for flood mitigation in and around informal settlements; (b) between food growing (urban agriculture) and flood reduction; between space for homes and space for water; (c) between living close to economic opportunity and having greater safety but some distance away from earning potential; and (d) between local politics resisting eviction and government goals for integrated urban drainage (Fig. 3). In reality, situations are much more complex than such a four-fold division suggests. To explore this complexity further, four case studies, ranging from a long-running series of attempts to improve a river to the introduction of urban greenways with some success, are now presented.

4.1. Old Fadama, Accra, Ghana

The contest between space for water and residential location is shown by the 31 ha Old Fadama informal settlement in Accra, Ghana, where densely packed self-built kiosks and shacks have encroached on to the floodplain of the Odaw River and the edge of Korle Lagoon (Fig. 4) (Farouk & Owusu, 2012). Next to Old Fadama and just 1.5 km from the Accra's city center, is the flourishing Agbogbloshie wholesale market, where people dismantle computers, automobile engines and refrigerators, adjacent to a wholesale vegetable market and dozens of street food stalls (Farouk & Owusu, 2012). The settlement has inadequate water supplies and only a few hundred toilets are shared by 80,000 people (Afenah, 2012). The Odaw River that feeds into the lagoon carries untreated sewage from parts of the Greater Accra area upstream, as well as contaminants from nearby electronic waste dumps and scavenging areas (Huang, Nkrumah, Anim, & Mensah, 2014; Monney, Odai, Buamah, Awuah, & Nyenje, 2013). The debris has reduced the capacity of both the Odaw Channel and the Korle Lagoon into which the Odaw discharges. Increased runoff, from the expanding impermeable surface-cover of the growing city and the reduced space for flood waters locally, has led to more frequent flooding in both Old Fadama and adjacent parts of the city. Particularly severe floods occurred in June in 2014 and 2015.

The political influence on municipal development needs (Table 4) is expressed here by the Accra Metropolitan Assembly's longstanding plans to dredge the Odaw channel and turn parts of the floodplain into an attractive urban greenspace. However, little progress has been made, mainly plans to clear at least part of Old Fadama. The delays are in part related to the economic significance of the role local resident workers play in the informal e-waste and appliance disassembly, metals recovery and recycling which forms a distinctive part of the urban economy and of Ghana's international trade (Grant, 2006). Activities at the Agbogbloshie market provide much tax revenue for the local economy. Removal of local workers from Old Fadama could harm Accra's urban commercial success (Afenah, 2012). Political considerations are also present. In 2016, with elections likely, evicting the squatters from Old Fadama would have been deemed political suicide, as both the ruling National Democratic Congress and the opposition New Patriotic Party draw large followings from residents of Old Fadama.

Table 4
Contrasts in needs related to contested floodplain and wetland areas in terms of integrated urban drainage management, informal settlements and municipal authorities.

Space for water needs	Informal settlement needs	Municipal development needs
Integrated pathways for water	Good drainage	No flooding of urban streets
Spaces to hold back storm runoff	Waste disposal systems	Land for commercial development
Channels free of debris	Water and sanitation	More employment opportunities
Absence of confining structures	Employment opportunities	Healthy environment
Bridges and culverts big enough for all storm flows	Access to health services	Public safety
	Absence of conflict	Solid waste management
	Political voices	Space for highways and utilities
	Security of tenure	
	Places to grow food	

Source: Compiled by the author.

In 2003 the Ghanaian government began to make efforts to restore the area close to Old Fadama through the Korle Lagoon Ecological Restoration Project (KLERP) which was intended to dredge the lagoon; remove contaminated material; reclaim parts of the surrounding area for parks and recreation areas; install sewage collection and treatment facilities; create embankments to protect the city center against flooding; and to preserve natural mangrove areas to sustain biodiversity and provide a green belt for the city (IMDC, 2011). The project depended on loans from KBC Bank NV of Belgium. The conditions attached to those loans involved evicting many local people. While the residents liked some aspects of the proposed improvements, they had major concerns about the type and amount of accommodation that would be provided for them if they were relocated on the periphery of Accra and about what alternative employment might be available (Farouk & Owusu, 2012). Over the following 13 years other attempts at eviction occurred, but despite some relocation sites offering favorable conditions, they were too far away from employment opportunities (residential location conflict on Fig. 3). Often the promised new facilities were not provided. By 2009, 79,684 residents lived in the area at a density of 26,600 per km^2 (2009) (Farouk & Owusu, 2012). The number of people potentially to be relocated had more than doubled, while the local informal sector had become more entrenched in the Accra economy.

In January 2013, Accra's mayor spoke of his resolve to clear Old Fadama for the KLERP project, but viable alternative housing for the residents has not been forthcoming (Asare, 2013). In September 2013, the Fadama Legal Assistance Program (FLAP) opened a fully equipped legal office in the settlement to help protect the rights of local residents (see: www.flap-ghana.org). However, the major flood event on 3rd June 2015, coupled with a disastrous fire at a petrol station in which some 150 people died, led to immediate political reactions. The President of Ghana, John Mahama, ordered a nationwide demolition of illegal structures. The mayor of Accra, in turn, said that the partial eviction of Old Fadama was the "greatest decision since Independence" (Rams, 2015). On 20 June 2015 the Accra Metropolitan Authority cleared the dwellings of over 50,000 Old Fadama residents. The stated reason was to enable the completion of the flood mitigation scheme (Lepawsky & Akese, 2015). However, the whole situation can also be interpreted as related to contrasting political influence (Fig. 3) and the gulf between residents' needs and municipal needs (Table 4).

This difficulty of removing people from floodplains is not easily resolved, but it seems to be more intractable in this Ghana locality than in most places. Even the draconian removal of people in June 2015 took only those living closest to the Odaw Channel, the bulk of the settlement remains in place (Personal communication J. Song-

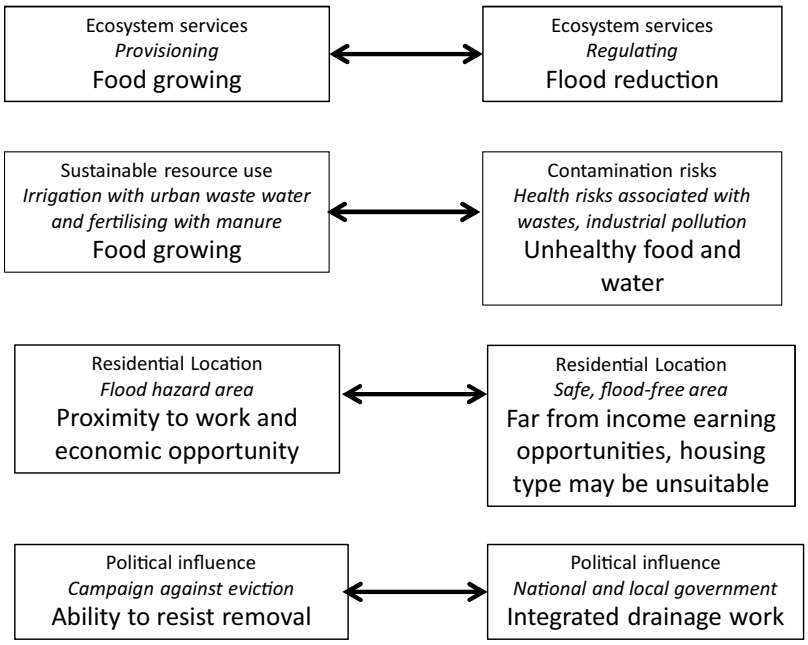

Fig. 3. Potential conflicts in ecosystem services, residential demands and political influence in tropical African urban floodplains and the use of green infrastructure to alleviate flooding.

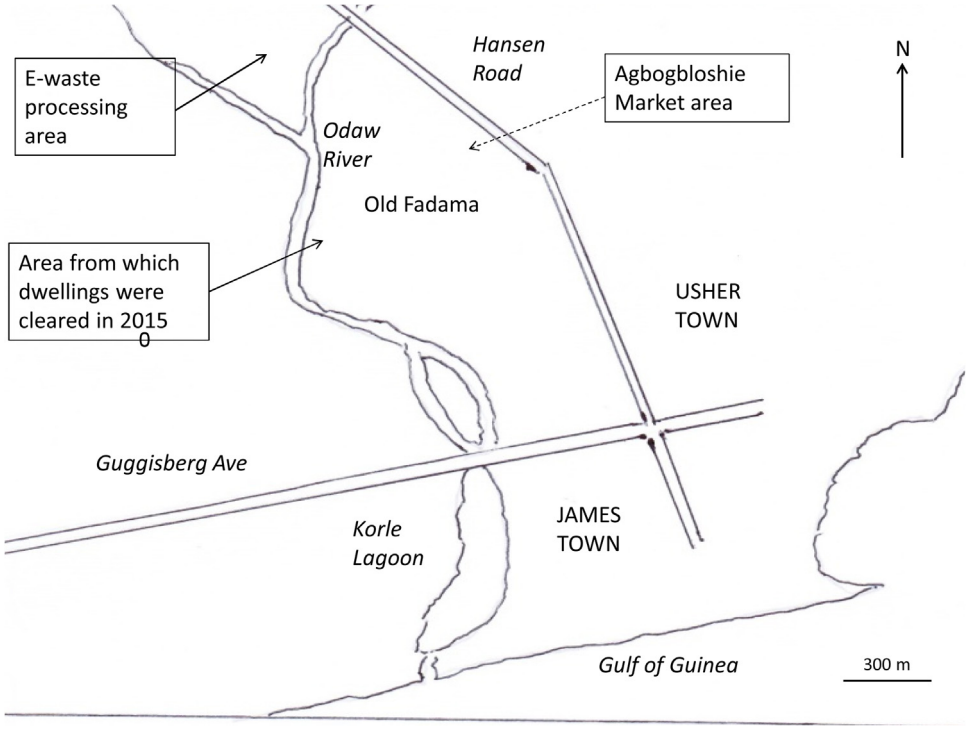

Fig. 4. Sketch map of Korle Lagoon and the Odaw River in Accra to show Old Fadama and surrounding areas.

sore, February 4, 2016). In addition to the electoral and economic considerations, there are concerns over: the true ownership of the land; the potential real estate value of the site due its proximity to the financial center of Accra; the wide gulf in living standards; the differences in the social goals of the wealthy elite and the poor; and the repeated failure of public participation and consultation (well described in Armah, Yawson, & Olsson, 2009; Yeebo, 2014). The many issues involved (Table 5) are likely to recur in other sub-tropical African cities and suggest that rehousing floodplain dwellers to allow green infrastructure to make space for water is going to be difficult.

4.2. Kampala, Uganda

The highest areas of Kampala are occupied by green low-density, upper class neighborhoods that comprise 18% of the built-up area, in contrast to the 21% of the present built-up area that is on, or adjacent to, low lying wetland zones (Vermeiren, Van Rompaey,

Table 5
Key issues arising from Old Fadama, related to the occupation of floodplains by informal settlements.

Environmental	Social	Political	Economic
Densely packed housing Untreated sewage on site and in river Highly polluted river with e-Waste debris and sewage Reduced Channel Capacity Siltation of Korle lagoon Frequent nuisance flooding	External NGO help e.g. Shack/ Slum Dwellers International Resident's uncertainty about their future housing Ease of access to work and city Internal diversity within settlement Failure of public participation and consultation	Government efforts to remove informal settlement Government plans for ecological restoration Repeated statements of intent by City Council Difficulty of enumerating population in the area	Migrant workers essential for local economy Normalization of the informal sector Persistent poverty

Source: Compiled by the author.

Loopmans, Serwajja, & Mukwaya, 2012). Kampala's annual 6.85% increase in built-up areas adds to impervious land surfaces. Bare land in the urban area, including clay pits, playing fields, eroded mud from quarries, market areas, poorly managed parking lots, dumped soil waste, and agricultural land, has led to increased runoff compared to that from adjacent forested areas (Ajambo, 2013; Fura, 2013).

Floodplains and wetlands in Kampala, with all their potential for multifunctional uses, including flood storage, are seen as opportunities for income by both the urban poor wishing to grow food and real-estate developers. Urban agriculture occurs around the edges of Kampala's major wetland areas, the Nsooba – Lubigi and Nakivubo Wetland systems along the rivers flowing out of Kampala into Lake Victoria (Vermeiren, Adiyia, Loopmans, & Tumwine, 2013). Since 2000 forests and open spaces adjoining these wetlands have been cleared by developers for construction and by local residents to establish informal settlements. Both of these clearance activities have encroached upon some wetland areas, both extending impermeable surfaces and reducing space for floodwater. In this situation, multifunctional greenspace land uses, including space for water, become more difficult to sustain, particularly when open spaces are handed over to the private sector. Kampala architect Doreen Adengo notes that in Kampala the most challenging landscape design task is to convince the developer not to destroy the wetland by filling it with sand and building on it, but rather to see it as an amenity and something that would add value to the adjacent housing development (see http://www.thenatureofcities.com/2014/12/04/how-can-different-ways-of-knowing-and-of-producingknowledge-be-useful-for-understanding-and-managing-urban-ecosystems/). Both new developments and urban agriculture are reducing opportunities for the general public to enjoy the cultural ecosystem services provided by urban greenspace (Kareem & Lwasa, 2014).

Measures to alleviate these flood problems include: increased enforcement of city regulations; demolition of illegal structures in the Nsooba-Lubigi wetland; the widening of existing drainage channels; and the construction of new drainage channels. Despite this integrated urban drainage work, there is still insufficient space for flood water from the biggest storms (NEMA, 2009).

Here urban agriculture (food growing) is in conflict with space for water (Fig. 3); land for real estate development is in conflict with space for water; and urban agriculture is in conflict with urban flood reduction (Fig. 3).

4.3. Nairobi, Kenya

In Nairobi over two million people live in informal settlements (Amnesty International, 2009). The largest of these is Kibera which has about 250,000 inhabitants, although some estimates suggest up to 800,000 (Ngugi, Benoit, Hallgrimsdottir, Jansson, & Roth, 2012) or 950,000 (Mutisya & Yarime, 2011). Only 10% of these people are shack owners who may also own many other shacks which they let out to tenants, leaving 90% of Kibera residents as tenants with no rights. Government intervention in the settlement has been weak and spasmodic, but a new upgrading program was initiated in 2015 (Fihlani, 2015). In the early 1990s, urban agriculture was practiced along stream banks and in spaces around the edges of the settlement, but subsequently the growth in population and the increased density of dwellings has left so little space that many residents have adapted lack of space for agriculture by engaging in sack gardening (Gallaher, Kerr, Njenga, Karanja, & WinklerPrins, 2013). Kibera farmers grow many vegetables in small spaces between dwellings, by planting vegetables into both the top and sides of soil and compost-filled sacks (Gallaher, Mankiw, Njenga, Karanja, & WinklerPrins, 2013).

However, for decades, many local and international NGOs have worked in Kibera, several of them contributing to projects with elements of green infrastructure creation and flood mitigation benefits. There are signs that space for water can be found alongside space for living (Fig. 3). One example is the "Trees for Cities" which in 2015 worked at the Centre for Community Development, to plant 6500 trees across multiple sites in Kibera. These ecosystem services provided by these trees include improved air quality, biomass increase, storm runoff attenuation, firewood and cultural values, especially education (see: http://www.treesforcities.org/about-us/projects/international-projects/kibera-kenya/kibera-slum-nairobi/). UNHabitat has encouraged tree planting in the area, with special events on World Habitat Day (see: http://mirror.unhabitat.org/content.asp?typeid=19&catid=669&cid=10127).

One of the more effective efforts to create multifunctional greenspaces in Kibera is the Kuonkey Design Initiative (KDI) project, in Nairobi's largest informal settlement. KDI, an international NGO combining architecture, landscape architecture, engineering and planning skills, engages in multi-stakeholder participation mobilizing community groups (and their local knowledge), the skills of design professionals, the political will of local government and the investment capacity of the private sector. It overcomes some of the potential conflict between political influence within the settlement and the political stance of local and national government (Fig. 3). It provides small scale slum improvement projects, combining flood alleviation with greenspace provision, food growing and enhanced human well-being. In addition it has been developing a digital flood map to assist in flood risk reduction in Kibera by identifying riparian zones and indicating the extent to which residents are living in flood hazard zones see: https://afritekt.wordpress.com/2016/01/11/land-and-water-resolving-the-tensions-of-climate-change-and-urbanisation-in-nairobis-largest-slum/. Another, independent, project, "Map Kibera" draws on youth ingenuity and participation to influence development using social IT media and digital mapping (www.mapkibera.org) helps to encourage broader social inclusion in the daily affairs of Kibera (Nairobi), as well as providing more accurate population data and information for urban planning and management. Map Kibera youth leaders are now included in

security planning by the national Ministry of Internal Security, helping to bridge the gap between Kibera residents' political goals and those of the national government (Fig. 3).

The KDI project emphasizes the ecosystem services provided by vegetation in terms of: flood control; bank erosion prevention; helping breakdown of organic waste; and providing oxygen for fish life (Odbert & Mulligan, 2014). Starting in 2006, KDI has helped some Kibera communities to transform their surroundings through the Kibera Public Space Project (KPSP), a bottom-up approach to slum upgrading activities. KPSP is a series of micro-interventions leading to the creation of a network of multifunctional open spaces that provide space for water and helping to reduce poverty, remediate rivers, enhance social cohesion, and raise living standards. By 2015, KDI had completed six KPSPs. The first KPSP intervention involved tackling many informal settlement needs (Table 4) by clearing a waste dump site, establishing an urban agriculture facility and controlling the persistent flooding with a new waterway. Existing channels were cleared and their banks reinforced by gabions and tree planting. Sites liable to flooding were reclaimed by creating new drainage channels and reinforcing river banks.

Kibera is cited as an example of urban fragility (UNHabitat, 2014). In the past there has been much conflict on ethnic lines within the settlement. The benefits of having dozens of NGOs, (social media reports claiming as many as 200, both international and local) working there have been questioned. Their well-intentioned efforts may not be sufficiently co-ordinated to contribute to the integrated urban drainage management that lies behind KDI's thinking. However, with considerable water and sanitation improvements in recent years, local writers are arguing that Kibera is a much better place than some non-Kenyan commentators suggest. Some feel that the goals of external organizations may not be those of the local people. Despite the apparently good work being done by NGO's, voices from within Kibera are suggesting that many efforts are not as effective as they should be and that the time has come to let the local people look after themselves:

"NGOs are not helping – they bring more problems than solutions. I have to say that they should leave us alone. They should be replaced by dedicated community leaders. Let people change themselves" (Asha Jaffar, Kibera born poet and writer, 2014).

The drainage work in Kibera shows what can be done. Multifunctional greenspaces can be created. Nevertheless, local voices, such as that of Asha Jaffar, suggest that ideas and projects should not be imposed, but should come out of fully co-operative partnerships embedded in the local community, as indicated by the KPSP and Trees for Cities projects, overcoming the potential conflicts between political influence within the community and that tied to external governments (Fig. 3).

4.4. Bobo-Dioulasso, Burkina Faso

Bobo-Dioulasso is the second largest city of Burkina Faso in terms of population, after its capital, Ouagadougou. It is located in the southwest of the country, 360 km from Ouagadougou. The city aims to overcome the potential conflict between food growing and flood reduction (Fig. 3) through a strategy to improve basic water, sanitation, solid waste, stormwater management and environmental education and an action plan for sustainable development of urban and peri-urban agriculture (PUA) (Baguian, 2013). A partnership between the Bobo-Dioulasso Municipal Unit for the Management of Climate Change and UN Habitat's Cities and Climate Change Initiative shows how urban agriculture and green infrastructure can be used to lessen the impact of climate and the risk of flooding (Sy, Baguian, & Gahi, 2014). The dual objectives are to reduce ambient temperatures and greenhouse gas emissions and improve local people's livelihoods by raising incomes and diversifying food supply (Box 3.5 in UNHabitat, 2014). The linear green infrastructure components being developed here are termed greenways and consist of corridors of undeveloped land preserved for recreational use or environmental protection. These greenways incorporate green open spaces, peri-urban forests and traditional market gardens. They have barriers to runoff and potential for stormwater storage. Flood mitigation is thus combined with other regulating and provisioning ecosystem services. A municipal charter of collaboration and permanent dialogue for a climate-resilient Bobo-Dioulasso was established (Ricci, Sanou, & Baguian, 2015). Political actors, technical experts, civil society, opinion leaders, the local residents and international organizations became involved in the planning process (Baguian, 2013). Sixty hectares of greenway had been completed by 2013.

The first pilot greenway project, covering 6., had the following functions: forest production; acting as windbreaks; providing shade; retaining run-off; and providing: sources of fuel and fodder; market gardening; and development of recreational and environmental education areas. Initial trials showed a 4% reduction in the run-off coefficient which would potentially lead to a reduction of flood risks and to increased infiltration and replenishment of subterranean water sources (Sy et al., 2014). With this and other evidence of the value of urban greenspace in mitigating urban surface temperatures, Bobo-Dioulasso developed policy guidelines on green infrastructure involving: setting-up a municipal committee to manage the greenways; a new greenways statute allowing urban agriculture; and a management system for the urban greenways (Leo, Escobedo, & Dubbeling, 2016). This case study suggests that urban greenspace networks can work successfully in an intertropical African city and can be designed to provide for both urban agriculture and flood reduction. Thus the conflict between resident's goals of food production and local governments concern for flood reduction (Fig. 3) might be successfully overcome.

5. Discussion: lessons from the case studies

Providing urban greenspace and installing SuDS in densely built-up areas is always difficult (Jones & McDonald, 2007). In practical terms, combinations of traditional hard engineering and greenspace based SuDS are often required. The character of the existing city, particularly of settlements in flood hazard zones; the present uses of any urban greenspace; and the priorities for human well-being have to be assessed when seeking to use greenspace to alleviate flooding. In informal settlements, complex political factors need to be taken into account, as is repeatedly shown by the events in Old Fadama (Gillespie, 2016a, 2016b).

In terms of the four levels of conflict over urban floodplains (Fig. 3) that between food growing and flood reduction takes on a slightly different dimension in Kampala, with infilling of wetlands by poor urban farmers and by private developers both reducing the space for water. Given the City's Department of Agriculture's powers to promote and protect peri-urban agriculture (Prain & Lee-Smith, 2010), appropriate wet season crops could be found to contribute to greenspace flood mitigation strategies,

Kibera on the other hand has little space between crowded dwellings. Sack farming has largely replaced vegetable plots along the river. Finding space for green infrastructure and SuDS is difficult, although the KDI project suggests it may be possible for local drainage within the settlement. Thus there is some hope for alleviating the potential conflict between space for living and space for water in the most crowded settlements. Whether clearance of dwellings encroaching on sectors of the floodplain of Nairobi's three main rivers to create space for rare, extreme flood flows would be possible without civil unrest is unclear.

Relocation, the favored option of most local governments and water engineering consultants all too often involves forced evic-

tions which will be resisted and thus only partly succeed, as shown repeatedly in Old Fadama. However, such resistance to eviction is most effective where there is a strong sense of community, a high degree of community organization, and also probably external assistance. The situation is complicated by the political interdependence of local politicians and voters in the settlements. The way politicians cultivate support from residents by helping people get access to services gives rise to particular patron–client relations between low-income residents, political parties, and the state (Dawson, 2014). Ethnic factors, especially among migrants from rural areas in different parts of country also complicate relationships. Multi-party politics over the provision of public services and access to housing divides groups in informal settlements (Awal & Paller, 2016). The importance of the political filter in implementing new planning and green infrastructure practices is particularly high in the intertropical African context (Douglas, 2014).

All four types of conflict (Fig. 3) exist among the case studies, but local circumstances vary. Although the early stages of the establishment of greenways in Bobo-Dioulasso appear to be successful, the city does not have the large, extremely dense informal settlements of the much bigger cities of Accra, Kampala and Nairobi. It has a few peripheral areas of informal housing, but the seasonal river channels are largely free of severe encroachment. Local situations and patterns of urban development are thus key factors in the likelihood of success in developing green infrastructure on the floodplains of intertropical African cities. Different levels and scales of concern within urban society produce contrasting views and strategies over what should be done about flooding. Floods also operate at different scales. Immediate action over local flooding caused by relatively frequent downpours involves community level responses as well as municipal strategies. At the other extreme, flooding from tropical cyclone rains that affect large rivers basins and huge area of countries requires national and river basin scale responses.

At present, in intertropical Africa, neither national planning nor local adaptations and responses appear to work well. SuDS and green infrastructure strategies are fine in principle but often difficult to implement in practice. The general literature and the case studies discussed here show that the planning, design and implementation of green infrastructure and SuDS strategies to alleviate flooding in intertropical Africa require understanding of local environmental processes, people's livelihoods, and political relationships between various levels of government and different parts of complex urban communities. The work also needs participatory processes, such as participatory vulnerability analysis (Douglas et al., 2008; Smit & Wandel, 2006) and capacity building among stakeholders through action learning (Tippett & Griffiths, 2007), which widens and shares among all parties the understanding of concerns and motivations affecting specific situations.

6. Conclusions

In tropical African countries, much of the population lives in informal settlements that encroach upon floodplains. Urban agriculture is practiced on many floodplains, with farmers often experiencing crop losses from flooding. Such situations may make the implementation of green infrastructure based SuDS difficult. Community adaptation to local flooding often involves temporary evacuation form flood-affected areas. After the flooding, people return to their riparian dwellings to continue to benefit from the advantages of locations in which they can survive, grow food and find a means of livelihood. However, continuing flood losses and increasing urban development require solutions at different scales, city-wide, or even for whole river basins. Many municipal flood alleviation strategies have not succeeded because communities have resisted eviction or because the intricacies of local political relationships have made governments unwilling to act. Complex alliances exist in informal settlement: between individual politicians and their supporters; between community organizations and international NGOs; between ethnic groups and political parties; and between land owners, tenants and government agencies. These lead to suspicions and failures of trust between those promoting change and those affected by change. Broadly, three major strategic patterns of change in flood losses and risk reduction are being promoted by governments, by internationally supported NGOs and by local community groups. Elements of all three are needed for effective solutions, but the prospects for getting their proponents to integrate, think holistically and deliver results are not bright.

The three broad strategies are: (1) a municipal-level vision of cleared floodways, probably of concrete-lined channels surrounded by carefully tended grassed floodplains that can be used for both recreation and SuDS; (2) an international expert and NGO vision if a green infrastructure that incorporates vegetated floodplains with some urban agriculture, providing multiple ecosystem services, that is planned and managed in consultation with local communities; and (3) community based strategies that emphasize the overall improvement of opportunity, security and living standards for the poor in informal settlements, including improvements in drainage, food production and the flood resilience of dwellings. Although often ignored in the first and second types of strategic vision, the community view is critical. Without holistic views across all scales of the political, social, economic and environmental aspects of these intertropical African cities, real progress in flood hazard reduction will too slow to protect the rapidly increasing numbers of people facing flood hazards in these urban places.

Acknowledgements

The many individuals who have shared their views of African cities with me include Kurshid Alam, Abraham Bello, Tanya Bowyer-Bower, Davinder Lamba, MaryAnne Maghenda, Asenath Omwega, David Satterthwaite, and Joseph Songsore. I thank them and also the members of the former Peri-Urban Environmental Change Project of the Scientific Committee on the Environment and of the Commonwealth Geographical Bureau's Workshop on Urban Geomorphology in Nairobi for their insights and excellent advice. I also thank Joan Nassauer and Sarah Lindley, as well as four anonymous referees, for their excellent comments on earlier versions of the paper, and Maureen Douglas for her excellent proof reading.

References

ActionAid. (2006). *Unjust waters Climate change, flooding and the protection of poor urban communities: Experiences from six African cities*. London: ActionAid International. Retrieved from http-//www.actionaid.org.uk/sites/default/files/doc_lib/unjust_waters.pdf

Afenah, A. (2012). Engineering in a millennium City in Accra, Ghana: The old Fadama intractable issue. *Urban Forum*, *23*, 527–540.

African Development Bank Group. (2010). *Nairobi River Rehabilitation and Restoration Program: Sewerage Improvement Project: Resettlement Action Plan for Compensation and Relocation.*. Retrieved from http-//www.afdb.org/fileadmin/uploads/afdb/Documents/Environmental-and-Social-Assessments/KENYA%20NairobiRiverSewerageProject%20ESIA%20Summary%20FINAL May%2031%202010%20%282%29.pdf

Ahern, J. (2007). Green Infrastructure for cities. The spatial dimension. In V. Novotny (Ed.), *Cities of the future. Towards integrated sustainable water and landscape management* (pp. 267–286). London: IWA Publications.

Ajambo, S. (2013). *Promoting private-public synergies for managing flooding in Kampala City—A case study of Bwaise, Parish III, Kawempe Division, Unpublished M.Sc. thesis*. Kristiansand, Norway: University of Agder.

Alderlieste, M. C., & Langeveld, J. G. (2005). Wastewater planning in Djenne, Mali—A pilot project for the local infiltration of domestic wastewater. *Water Science and Technology*, *51*(2), 57–64.

Amnesty International. (2009). *Kenya – The unseen majority – Nairobi's two million slum dwellers*. London: Amnesty International Publications. Retrieved 19.08.16 from http-//www.amnesty.nl/sites/default/files/public/rap_kenia_the_unseen_majority.pdf

Amusat, A. S., & Amusat, K. K. (2013). Effects of flood on farmers in peri-urban area of Ibadan, Oyo state, Nigeria. *Journal of Environmental Extension*, *11*. Retrieved from http-//www.ajol.info/index.php/jext/article/view/110558

Armah, F. A., Yawson, D. O., & Olsson, J. A. (2009). The gap between theory and practice of stakeholder participation—The case of management of the Korle Lagoon, Ghana. *Law, Environment and Development Journal*, *5*(1), 73–88. Retrieved from http-//www.lead-journal.org/content/09073.pdf

Asare, A. A. (2013). *Facing Old Fadama. Ghana Web, 23 March 2013*.. Retrieved 20.04.15 from www.ghanaweb.com/GhanaHomePage/features/artikel.php?ID=268693

Aubry, C., Ramamonjisoa, J., Dabat, M.-H., Rakotoarisoa, J., Rakotondraibe, J., & Rabehariso, L. (2012). Urban agriculture and land use in cities: An approach with the multi-functionality and sustainability concepts in the case of Antananarivo (Madagascar). *Land Use Policy*, *29*, 429–439.

Awal, M., & Paller, J. (2016). *Who Really Governs Urban Ghana?* Retrieved 14.08.16 from http-//www.africaresearchinstitute.org/publications/who-really-governs-urban-ghana/

Baguian, H. (2013). *Green mosaic planning in Bobo-Dioulasso*.. Retrieved 12.03.16 http-//resilient-cities.iclei.org/fileadmin/sites/resilient-cities/files/Resilient_Cities_2013/Presentations/D5_Baguian_RC2013_RUFS.pdf

Benedict, M. A., & McMahon, E. T. (2002). Green infrastructure: smart conservation for the 21 st century? *Renewable Resources Journal*, *20*(3), 12–17.

Chitekwe-Biti, B., Mudimu, P., Nyama, G. M., & Jera, T. (2012). Developing an informal settlement upgrading protocol in Zimbabwe—The Epworth story. *Environment & Urbanization*, *24*(1), 131–148. http://dx.doi.org/10.1177/0956247812437138

Cimini, S., & Orazi, S. (2016). Operative public space for informal Nairobi: The why not junior academy experience. In S. Attia, S. Shabka, Z. Shafik, & A. A. A. M. Ibrahim (Eds.), *Dynamics and resilience of informal areas* (pp. 131–147). Zurich: Springer International Publishing.

Cissé, O., & Séye, M. (2016). Flooding in the suburbs of Dakar: impacts on the assets and adaptation strategies of households or communities. *Environment & Urbanization*, *28*(1), 183–204. http://dx.doi.org/10.1177/0956247815613693

Cissé, G., Koné, B., Bâ, H., Mbaye, I., Koba, K., Utzinger, J., et al. (2011). Ecohealth and climate change: Adaptation to flooding events in Riverside Secondary Cities, West Africa. In K. Otto-Zimmermann (Ed.), *Resilient cities* (pp. 55–67). Dordrecht: Springer.

Connors, J. P., Griffith, C. A., Nolasco, C. L., Wahab, B., & Mugagga, F. (2016). Cultivating urban climate resilience. In K. C. Seto, W. D. Solecki, & C. A. Griffiths (Eds.), *The routledge handbook of urbanization and global environmental change* (pp. 421–440). London: Routledge.

Dawson, H. J. (2014). Patronage from below: Political unrest in an informal settlement in South Africa. *African Affairs*, *113*(453), 518–539. http://dx.doi.org/10.1093/afraf/adu056

Defra Making space for water: Taking forward a new Government strategy for flood and coastal erosion risk management in England: First Government response to the autumn 2004 Making space for water consultation exercise, (2005). Defra; London, PB10516.

Diagne, K. (2007). Governance and natural disasters: Addressing flooding in Saint Louis, Senegal. *Environment and Urbanization*, *19*(2), 552–562.

Dixon, A. B., & Wood, A. P. (2003). Wetland cultivation and hydrological management in eastern Africa: Matching community and hydrological needs through sustainable wetland use. *Natural Resources Forum*, *23*(2), 117–129.

Dobson, S., Nyamweru, H., & Dodman, D. (2015). Local and participatory approaches to building resilience in informal settlements in Uganda. *Environment and Urbanization*, *27*(2), 605–620.

Douglas, I., Alam, K., Maghenda, M., McDonnell, Y., Mclean, L., & Campbell, J. (2008). Unjust waters: Climate chang, flooding and the urban poor in Africa. *Environment & Urbanization*, *20*(1), 187–205.

Douglas, I. (1983). *The urban environment*. London: Edward Arnold.

Douglas, I. (2014). The political filter in the local implementation of initiatives relating to urban ecology. *Landscape and Urban Planning*, *125*, 312–319.

Dubbeling, M., & de Zeeuw, H. (2011). Urban agriculture and climate change adaptation: ensuring food security through adaptation. In K. Otto-Zimmermann (Ed.), *Resilient cities: cities and adaptation to climate change – proceedings of the global forum 2010, Local Sustainability 1* (pp. 441–449). Dordrecht: Springer Science+Business Media B.V. http://dx.doi.org/10.1007/978-94-007-0785-6_44

Durand-Lasserve, A. (2006). Informal settlements and the millennium development goals-global policy debates on property ownership and security of tenure. *Global Urban Development*, *2*(1), 1–15.

Farouk, B. R., & Owusu, M. (2012). If in doubt count—The role of community-driven enumerations in old Fadama, Accra. *Environment & Urbanization*, *24*(1), 47–47.

Fihlani, P. (2015). *Kenya's Kibera slum gets a revamp*.. Retrieved 12.03.16 from http-//www.bbc.co.uk/news/world-africa-31540911

Foeken, D., & Mwangi, A. M. (1998). *Farming in the City of Nairobi (ASC working paper 30)*. Leiden: African Studies Centre. Retrieved 27.07.16 from http-//www.ascleiden.nl/pdf/wp30.pdf

Foeken, D., & Mwangi, A. M. (2000). Increasing food security through urban farming in Nairobi. In N. Bakker, M. Dubbeling, S. Gündel, U. Sabel-Koschella, & H. de Zeeuw (Eds.), *Growing cities, growing food: Urban agriculture on the policy agenda* (pp. 303–307). Feldafing (Germany): Food and Agriculture Development Centre.

Fura, G. D. (2013). *Analyzing and modelling urban land cover change for run-off modelling in Kampala, Uganda, Unpublished M.Sc. Thesis*. Enschede: University of Twente.

Gallaher, C. M., Kerr, J. M., Njenga, M., Karanja, N. K., & WinklerPrins, A. M. G. A. (2013). Urban agriculture, social capital, and food security in the Kibera slums of Nairobi, Kenya. *Agriculture and Human Values*, *30*, 389–404. http://dx.doi.org/10.1007/s10460-013-9425-y

Gallaher, C. M., Mankiw, D., Njenga, M., Karanja, N. K., & WinklerPrins, A. M. G. A. (2013). Real or perceived: The environmental health risks of urban sack gardening in Kibera Slums of Nairobi, Kenya. *EcoHealth*, *10*, 9–20.

Gaye, M., & Diallo, F. (1997). Community participation in the management of the urban environment in Rufisque (Senegal). *Environment & Urbanization*, *9*(1), 9–29.

Gichere, S., Sikoyo, G. M., & Saidi, A. M. (2011). Climate change and its effect on Cities of Eastern African Countries. In B. Yuen, & A. Kumssa (Eds.), *Climate change and sustainable urban development in Africa and Asia* (pp. 211–220). Dordrecht: Springer.

Gillespie, T. (2016a). Accumulation by urban dispossession: Struggles over urban space in Accra, Ghana. *Transactions of the Institute of British Geographers*, *41*, 66–77. http://dx.doi.org/10.1111/tran.12105

Gillespie, T. (2016b). From quiet to bold encroachment: Contesting dispossession in Accra's informal sector. *Urban Studies*, http://dx.doi.org/10.1080/02723638.2016.1191792, published online

Grant, R. (2006). Out of place? Global citizens in local spaces: A study of informal settlement in the Korle Lagoon environs in Accra, Ghana. *Urban Forum*, *17*(1), 1–24.

Hannam, I. D., & Hicks, R. W. (1980). Soil conservation and urban land use planning. *Journal of the Soil Conservation Service of New South Wales*, *36*, 135–145.

Hannam, I. D. (1979). Urban soil erosion: An extreme phase in the Stewart subdivision West Bathurst. *Journal of the Soil Conservation Service of New South Wales*, *35*(1), 19–25.

Hansen, R., & Pauleit, S. (2014). From multifunctionality to multiple ecosystem services?—A conceptual framework for multifunctionality in green infrastructure planning for urban areas. *Ambio*, *43*, 516–529. http://dx.doi.org/10.1007/s13280-014-0510-2

Heath, T., Parker, A. H., & Weatherhead, E. K. (2012). Testing a rapid climate change adaptation assessment for water and sanitation providers in informal settlements in three cities in sub-Saharan Africa. *Environment and Urbanization*, *24*(2), 619–637. http://dx.doi.org/10.1177/0956247812453540

Holder, C. (2014). Growing hope – how urban gardens are empowering war-Affected liberians and harvesting a new generation of city farmers. In K. G. Tidball, & M. E. Krasny (Eds.), *Greening in the red zone-disaster, resilience and community greening* (pp. 417–427). Dordrecht: Springer Science+Business Media. http://dx.doi.org/10.1007/978-90-481-9947-1_32

Hooper, M., & Ortolano, L. (2012). Motivations for slum-dweller social movement participation in urban Africa—A study of mobilization in Kurasini, Dar es Salaam. *Environment & Urbanization*, *24*(1), 99–114. http://dx.doi.org/10.1177/0956247811435889

Huang, J., Nkrumah, P. N., Anim, D. O., & Mensah, E. (2014). E-waste disposal effects on the aquatic environment – Accra, Ghana. In D. M. Whitacre (Ed.), *Reviews of environmental contamination and toxicology* (vol. 229) (pp. 19–34). http://dx.doi.org/10.1007/978-3-319-03777-6_2

IMDC. (2011). *Rehabilitation of Korle Lagoon and its river system in Accra*. Antwerp: International Marine & Dredging Consultants (IMDC). Retrieved 11.03.16 from http-//www.imdc.be/projects/rehabilitation-korle-lagoon-and-its-river-system-accra

Iwugo, K. O., Andoh, R. Y. G., & Feest, A. F. (2002). Cost-effective integrated drainage and wastewater management systems. *Journal of the Chartered Institution of Water and Environmental Management*, *16*(1), 53–57.

Jaffar, A. (2014). *Failed Donor Aid*.. Retrieved 11.03.16 from http-//haller.org.uk/haller-prize/prizewinners/

Jean-Baptiste, N., Kabisch, S., & Kuhlicke, C. (2013). Urban vulnerability aAssessment in flood-prone areas in West and East Africa. In S. Rauch, G. Morrison, S. Norra, & N. Schleicher (Eds.), *Urban environment: Proceedings of the 11th urban environment symposium (UES), held in Karlsruhe, Germany, 16-19 september 2012* (pp. 205–215).

Jones, P., & McDonald, N. (2007). Making space for unruly water—Sustainable drainage systems and the disciplining of surface runoff. *Geoforum*, *38*(3), 534–544. http://dx.doi.org/10.1016/j.geoforum.2006.10.005

Kareem, B., & Lwasa, S. (2014). Gender responsiveness in infrastructure provision for African cities—The case of Kampala in Uganda. *Journal of Geography and Regional Planning*, *7*(1), 1–9. http://dx.doi.org/10.5897/JGRP2013.0424

Klopp, J. M. (2008). Remembering the destruction of muoroto—Slum demolitions, land and democratization in Kenya. *African Studies*, *67*(3), 295–314. http://dx.doi.org/10.1080/000 20180802504866

Lee-Smith, D. (2010). Cities feeding people: An update on urban agriculture in equatorial Africa. *Environment & Urbanization*, *22*(2), 483–499.

Leo, N. D., Escobedo, F. J., & Dubbeling, M. (2016). The role of urban green infrastructure in mitigating land surface temperature in Dioulasso, Bobo-Burkina Faso. *Environment, Development & Sustainability*, *18*, 373–392. http://dx.doi.org/10.1007/s10668-015-9653-y

Lepawsky, J., & Akese, G. (2015). *Sweeping away Agbogbloshie again*.. Retrieved 7.03.16 from http-//discardstudies.com/2015/06/23/sweeping-away-agbogbloshie-again/

Lindley, S. J., Gill, S. E., Cavan, G., Yeshitela, K., Nebebe, A., Woldegerima, T., et al. (2015). Green infrastructure for climate adaptation in African Cities. In S. Pauleit, A. Coly, S. Fohlmeister, P. Gasparini, G. Jørgensen, S. Kabisch, W. J. Kombe, S. Lindley, I. Simonis, & K. Yeshitela (Eds.), *Urban vulnerability and*

climate change in Africa, Future City 4 (pp. 107–152). Zurich: Springer International Publishing.
Lwasa, S., Mugagga, F., Wahab, B., Simon, D., Connors, J., & Griffith, C. (2014). Urban and peri-urban agriculture and forestry: Transcending poverty alleviation to climate change mitigation and adaptation. *Urban Climate*, *7*, 92–106.
Majani, B. B. (1996). Coping with urban growth and development through environmental planning and management (EPM)—The sustainable Dar-es-Salaam project. *Urban Health Newsletter*, *28*, 26–31.
Mance, G., Raven, P. J., & Bramley, M. E. (2002). Integrated river basin management in England and Wales—A policy perspective. *Aquatic Conservation*, *12*, 425–437.
Mbiba, B. (2000). Urban agriculture in Harare: between suspicion and repression. In N. Bakker, M. Dubbeling, S. Gündel, U. Sabel-Koschella, & H. de Zeeuw (Eds.), *Growing cities, growing food: urban agriculture on the policy agenda – a reader on urban agriculture* (pp. 285–301). GTZ; Feldafing.
Mguni, P., Herslund, L., & Jensen, M. B. (2015). Green infrastructure for flood-risk management in Dar es Salaam and Copenhagen: Exploring the potential for transitions towards sustainable urban water management. *Water Policy*, *17*(1), 126–142. http://dx.doi.org/10.2166/wp.2014.047
Mitchell, V. G. (2006). Applying integrated urban water management concepts—A review of australian experience. *Environmental Management*, *37*(5), 589–605.
Mo Ibrahim Foundation. (2016). *Facts and Figs. 2015 African Urban Dynamics*.. Retrieved 19.08.16 from http-//static.moibrahimfoundation.org/u/2015/11/19115202/2015-Facts-Figures-African-Urban-Dynamics.pdf
Monney, I., Odai, S. N., Buamah, R., Awuah, E., & Nyenje, P. M. (2013). Environmental impacts of wastewater from urban slums – case study – old Fadama, Accra. *International Journal of Development and Sustainability*, *2*(2), 711–728.
Mupedziswa, R. (2011). Climate change and its effect on urban housing and liveable cities: The case of Harare, Zimbabwe. In B. Yuen, & A. Kumssa (Eds.), *Climate change and sustainable urban development in Africa and Asia* (pp. 243–262). Dordrecht: Springer Science+Business Media. http://dx.doi.org/10.1007/978-90-481-9867-2_14
Mutisya, E., & Yarime, Y. (2011). Understanding the grassroots dynamics of slums in Nairobi—The dilemma of Dilemma of Kibera settlements international transaction. *Journal of Engineering, Management, & Applied Sciences & Technologies*, *2*(2), 197–213.
NEMA. (2009). *Uganda: Atlas of our changing environment*. Kampala: National Environment Management Authority (NEMA). Retrieved 27.07.16 from http-//www.grida.no/files/publications/uganda-atlas-2009.pdf
Ngugi, E. N., Benoit, C., Hallgrimsdottir, H., Jansson, M., & Roth, E. A. (2012). Family kinship patterns and female sex work in the informal urban settlement of Kibera, Nairobi, Kenya. *Human Ecology—An Interdisciplinary Journal*, *40*(3), 397–403. http://dx.doi.org/10.1007/s10745-012-9478-3
Odbert, C., & Mulligan, J. (2014). The Kibera public space project: Participation, integration and networked change. In J. Hou, B. Spencer, T. Way, & K. Vocom (Eds.), *New urbanism the Future City is here* (pp. 178–192). London: Routledge.
Olorunfemi, F. B., & Raheem, U. A. (2013). Floods and rainstorms impacts, responses and coping among households in Ilorin, Kwara State. *Journal of Educational and Social Research*, *3*(4), 135–145.
Onifade, O. A., Adio-Moses, R., Adigun, J. O., Oguntunji, I. O., & Ogungboye, R. O. (2014). Impacts of flood disaster on sustainable national development in Ibadan North local government, Oyo State. *Arabian Journal of Business and Management Review (OMAN Chapter)*, *4*(2), 139–147.
Otiso, K. M. (2002). Forced evictions in Kenyan cities. *Singapore Journal of Tropical Geography*, *23*(3), 252–267.
Owusu-Ansah, J. K. (2016). The influences of land use and sanitation infrastructure on flooding in Kumasi, Ghana. *GeoJournal*, *81*(4), 555–570.
Penning-Rowsell, E. C., & Tunstall, S. M. (1996). Risks and Resources: Defining and managing the floodplain. In M. G. Anderson, D. E. Walling, & P. D. Bates (Eds.), *Floodplain processes* (pp. 492–534). Chichester: Wiley.
Ponte, E. (2014). Flood risk due to heavy rains and rising sea levels in the municipality of Maputo. In S. Macchi, & M. Tiepolo (Eds.), *Climate change vulnerability in Southern African cities* (pp. 187–203). Zurich: Zurich: (Springer Climate) Springer International Publishing Switzerland.
Prain, G., & Lee-Smith, D. (2010). Urban agriculture in Africa—What has been learned? In G. Prain, N. Karanja, & D. Lee-Smith (Eds.), *African urban harvest: Agriculture in the cities of Cameroon, Kenya and Uganda* (pp. 13–38). New York: Springer with IDRC and CIP. http://dx.doi.org/10.1007/978-1-4419-6250-8_2
Rams, D. (2015). *Rambo style urban management. Open Democracy*.. Retrieved 28.07.16 from https-//www.opendemocracy.net/dagna-rams/rambostyle-urban-management
Rauch, W., Seggelke, K., Brown, R., & Krebs, P. (2005). Integrated approaches in urban storm drainage—Where do we stand? *Environmental Management*, *35*(4), 396–409.
Ricci, L., Sanou, B., & Baguian, H. (2015). Climate risks in West Africa: Bobo-Dioulasso local actors' participatory risks management framework. *Current Opinion in Environmental Sustainability*, *13*, 42–48. http://dx.doi.org/10.1016/j.cosust.2015.01.004
Ricci, L. (2016). *Reinterpreting Sub-Saharan Cities through the concept of adaptive capacity, (Springer briefs in environment, security, development and peace 26)*. New York: Springer. http://dx.doi.org/10.1007/978-3-319-27126-2_3
Robinson, G. D., & Speiker, A. M. (1978). Nature to be commanded..Earth-science maps applied to land and water management. In *US geological survey professional paper 950*.
Satterthwaite, D., Huq, S., Pelling, M., Reid, H., & Romero Lankao, P. (2007). *Adapting to climate change in urban areas? The possibilities and constraints in low and middle-Income countries (Human settlements climate change and cities discussion series 1)*. London: IIED.
Satterthwaite, D., Huq, S., Pelling, M., Reid, H., & Romero Lankao, P. (2009). Adapting to climate change in urban areas: The possibilities and constraints in low and middle-Income nations. In J. Bicknell, D. Dodman, & D. Satterthwaite (Eds.), *Adapting cities to climate change: Understanding and addressing the development challenges* (pp. 2–47). London: Earthscan.
Satterthwaite, D., McGranahan, G., & Tacoli, C. (2010). Urbanization and its implications for food and farming. *Philosophical Transactions of the Royal Society B*, *365*, 2809–2820. http://dx.doi.org/10.1098/rstb.2010.0136
Sawio, C. J. (1994). Who are the farmers of Dar-es-Salaam? In A. G. Egziabher, D. Lee-Smith, D. G. Maxwell, P. A. Memon, L. J. A. Mougeot, & C. J. Sawio (Eds.), *Cities feeding people: An examination of urban agriculture in East Africa* (pp. 23–44). Ottawa: IDRC.
Simon, D. (2013). Climate and environmental change and the potential for greening African cities. *Local Economy*, *28*(2), 203–217.
Smit, J., Nasr, J., & Ratta, A. S. (1996). *Urban agriculture: Food, jobs and sustainable cities*. New York: The Urban Agriculture Network, Inc.
Smit, B., & Wandel, J. (2006). Adaptation: Adaptive capacity and vulnerability. *Global Environmental Change*, *16*, 282–292.
Standing committee on agriculture and resource management floodplain management in Australia: Best practice principles and guidelines, (2000). CSIRO SCARM Report 73; Collingwood, Vic.
Sy, M., Baguian, H., & Gahi, N. (2014). Multiple use of green spaces in Bobo Dioulasso, Burkina Faso. *Urban Agriculture Magazine*, *27*, 27–36.
Taiwo, O. J. (2014). Determinants of peri-urban and urban agricultural locational choice behavior in Lagos, Nigeria. *Land Use Policy*, *39*, 320–330.
Thorn, J., Thornton, T. F., & Helfgot, A. (2015). Autonomous adaptation to global environmental change in peri-urban settlements: Evidence of a growing culture of innovation and revitalisation in Mathare Valley Slums, Nairobi. *Global Environmental Change*, *31*, 121–131. http://dx.doi.org/10.1016/j.gloenvcha.2014.12.009
Tippett, J., & Griffiths, E. J. (2007). New approaches to flood risk management-implications for capacity building. In R. Ashley, S. Garvin, E. Pasche, A. Vassilopoulos, & C. Zevenbergen (Eds.), *Advances in urban flood management* (pp. 383–414). London: Taylor & Francis.
Tukahirwa, J. T., Mol, A. P. J., & Oosterveer, P. (2010). Civil society participation in urban sanitation and solid waste management in Uganda. *Local Environment: The International Journal of Justice and Sustainability*, *15*(1), 1–14. http://dx.doi.org/10.1080/13549830903406032
UNEP. (2009). *Kenya: Atlas of our changing environment*. Nairobi: Division of Early Warning and Assessment (DEWA), United Nations Environment Programme (UNEP). Retrieved 10.08.16 from http-//na.unep.net/atlas/kenya/downloads/chapters/kenya_screen_chapter5-end.pdf
UNHabitat. (2014). *State of african cities report 2014—Reimagining sustainable urban transitions*. Gigiri, Kenya: UNHabitat.
Vedeld, T., Coly, A., Ndour, N. M., & Hellevik, S. (2016). Climate adaptation at what scale? Multi-level governance, resilience, and coproduction in Saint Louis, Senegal. *Natural Hazards*, *82*, 173–199. http://dx.doi.org/10.1007/s11069-015-1875-7
Vermeiren, K., Van Rompaey, A., Loopmans, M., Serwajja, E., & Mukwaya, P. (2012). Urban growth of Kampala, Uganda: Pattern analysis and scenario development. *Landscape and Urban Planning*, *106*, 199–206.
Vermeiren, K., Adiyia, B., Loopmans, M., Tumwine, F. R., & Van Rompaey, A. (2013). Will urban farming survive the growth of African cities?—A case-study in Kampala (Uganda). *Land Use Policy*, *35*, 40–49.
Wakhungu, J., Huggins, C., Nyukuri, E., & Lumumba, J. (2010). *Approaches to informal urban settlements in Africa: Experiences from Kigali and Nairobi: Policy Brief*. Nairobi: African Center for Technology Studies.
Weru, J. (2004). Community federations and city upgrading—The work of Pamoja Trust and Muungano in Kenya. *Environment & Urbanization*, *16*(1), 47–62.
Yeebo, Y. (2014). *The Bridge to Sodom and Gomorrah*.. Retrieved 20.04.16 from http-//www.thebigroundtable.com/stories/the-bridge-to-sodom-and-gomorrah/
Zvigadza, S. (2008). Climate change vulnerability mapping: the case of the city of Harare, Zimbabwe. In *Paper presented at Cities and climate change workshop*.